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8.5 Noise Control and Privacy

Like air quality and lighting, a good acoustic environment is essential in maintaining a high level of satisfaction and morale among workers. Ideally, offices and other workspaces should be free of noise and audible information that distracts them from the tasks at hand. Additionally, acoustic privacy is necessary for some tasks. Noise and distracting sounds can come from both indoor and outdoor sources. They may be continuous and irritating, such as the buzz of magnetic ballasts, or they may be sporadic, such as an occasional loud voice. Speech is the most prolific and disruptive noise in most offices because it can be difficult to ignore.

Opportunities

Noise can be controlled most effectively, and at the least expense, if it is considered alongside other building performance parameters early in the design of a new building or renovation. During the schematic design it is possible, for example, to provide maximum separation between sources of noise and the spaces that have the greatest need for quiet. In addition, choices regarding the degree of acoustic dampening and isolation between spaces can also affect options for air distribution, lighting, and other systems. For example, indirect lighting schemes supplemented by task lighting reflect less sound than recessed troffers with plastic covers, and they may be easier to justify in a budget if their acoustic benefits are also taken into account.

In an existing facility, the impact of changes on the noise level in adjacent spaces should be considered whenever mechanical or electrical equipment is being serviced or replaced. Regular maintenance can help keep machines running quietly and efficiently.

Technical Information

Concepts important in addressing acoustical problems in buildings include the following:

- **Background noise** is needed to provide some masking of sound, but too much noise is stressful and can make it difficult to hear conversations or other communications. Noise criteria (NC) have been used to rate sources of background noise in the past. More recently, room criteria (RC) have become widespread as a rating system for overall noise levels. Studies have shown that an RC rating between 35 and 45 will usually provide speech privacy in open-plan settings, while ratings below 35 will not.
- **Speech privacy potential (SPP)** quantifies the percentage of words that can be understood from an adjacent conversation and is related to sound isolation and background noise. SPP is directly proportional to occupant satisfaction, and GSA recommends a minimum value of 60 for SPP in open offices; an SPP of 70 is considered good for closed-office plans. GSA-sponsored research for open office areas revealed that speech privacy can be improved either by increasing the sound attenuation between workstations or by increasing the background noise. Another measure of speech privacy is the articulation index (AI), which ranges from 0 (speech not at all intelligible) to 1.0 (fully intelligible).

Basic principles of sound control include these:

- Reducing noise at its source.
- Blocking noise transmission.
- Absorbing noise.
- Masking noise.
- Active noise cancellation.

Reducing noise at its source is an important first step in addressing internally generated sounds. Noise from mechanical and electrical equipment is a release of energy that is not contributing to the intended tasks, and as a result it is a symptom of inefficiency in the system. In some cases, reduced noise may be a contributing factor that can help justify the selection of higher-efficiency equipment. Air-handler noise transmission can be reduced by providing flexible connections between the air handler and ductwork and by using duct liners. Carpets are effective at preventing footfall noise from pedestrian traffic through a space.

Blocking noise transmission is achieved primarily with high-mass barriers that are rated by sound transmission class (STC). Both internally generated and exterior noises can be controlled to some extent in this way. For exterior noise, a high-mass, airtight building shell is important. Windows tend to be a weak link in this respect. Double-glazed windows are more effective with a wide space between the panes, or with sulfur hexafluoride (SF_6) gas fill. The need for noise control makes it particularly difficult to use natural ventilation or operable windows for buildings in noisy settings. Natural earth berms and other massive external barriers can also be effective at managing noise from highways or other nearby sources.

Barriers are also important to control the transmission of conversation and other indoor noises. In open office systems, partitions lower than 50 in. (1.3 m) in height are largely ineffective, while those over 70 in.

(1.8 m) are subject to diminishing returns. Minimizing spaces below dividers and at their joints is also important. In the case of full-wall partitions, airtightness is important to minimize sound leakage. In some cases it may be advisable to extend interior partitions past the suspended ceiling and up to the slab above, but such extensions complicate air distribution and other systems. One solution is use slab-to-slab partitions between adjacent offices but not between offices and corridors. Adding a foil backing to suspended ceiling tiles will also reduce the sound transmitted through the ceiling.

Absorbing noise is an essential component of any office noise-management plan. Reflective surfaces allow noises to travel over a significantly greater distance, and sound levels tend to be much higher. Absorption in ceilings, in furniture panels, on the floors, and on walls (where necessary) helps to lower noise levels and reduce the distance over which sound travels. Of these surfaces, acoustical ceilings and workstation dividers tend to be most effective at absorbing sound.

The noise reduction coefficient (NRC) is a measure of how effective a material is at absorbing sound. NRC ratings range from nearly 0 for a hard, reflective material to 1.0 for a highly absorptive material. Effective ceiling tiles should have an NRC rating close to 0.9.

SOUND INTENSITY LEVELS OF TYPICAL NOISES

Sound Pressure (Pa)	Sound Intensity (W/m^2)	Decibels (dB)	Noise in the Environment
63.2	10	130	Threshold of pain
20	1	120	Near a jet aircraft at take-off
6.32	0.1	110	Riveting machine
2.0	0.10	100	Pneumatic hammer
0.632	0.001	90	
0.2	0.0001	80	Diesel truck at 50 ft (15 m) Shouting at 3 ft (1 m)
0.0632	1×10^{-5}	70	Busy office
0.02	1×10^{-6}	60	Conversational speech at 3 ft (1 m)
0.00632	1×10^{-7}	50	Quiet urban area during daytime
0.002	1×10^{-8}	40	Quiet urban area at night
0.000632	1×10^{-9}	30	Quiet suburban area at night
0.0002	1×10^{-10}	20	Quiet countryside
0.000632	1×10^{-11}	10	Human breathing
0.00002	1×10^{-12}	0	Threshold of audibility

Loudness or noise can be measured in various units. The decibel scale provides a convenient way to express this. Note that the quietest sound we can hear is one ten-trillianth (1×10^{-13}) as loud as the most intense noise we experience.

Adapted from: *Architectural Acoustics: Principles and Design* by Madan Mehta, Jim Johnson, and Jorge Rocafort (Prentice-Hall, Upper Saddle River, NJ, 1999)

Sound-masking systems artificially raise the background noise level to maintain speech privacy. Unlike older "white noise" generators, modern systems adjust sounds levels at various frequencies to meet acoustical objectives, while remaining relatively unobtrusive to occupants. The systems consist of an array of speakers that are usually located above a suspended ceiling on a 15-foot (5-meter) grid. The speakers project sound upwards so that it is reflected off the underside of the slab above. Although high-tech, such masking systems are often more cost-effective than alternative means of increasing acoustic privacy and reducing distractions. A good sound-masking system should reduce distractions as much as if the STC rating of the sound barriers was increased by 10 points.

Active noise cancellation (ANC) systems consist of microphones that receive the target noise and speakers that create an identical sound field 180 degrees out of phase with the original noise. The sound field created effectively reduces the effect of the offending noise but does not cancel it. Some ANC systems are made for use in HVAC ductwork to prevent problem noise from disturbing occupants. Active noise cancellation only works for low-frequency constant noises (such as that of generators and motors) when both the noise source and the listener are stationary. It has little or no application to office environments but may be useful in certain specialized facilities.

References

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